

Delivering Digital Services

WXXM-based Data Models for FAA NextGen Weather Products

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Federal Aviation
Administration



EUROCONTROL

Air Transportation Information Exchange Conference

(Featuring Notam Industry Day, Monday August 25, 2014)

Delivering Digital Services

August 26 - 28, 2014
NOAA Auditorium and Science Center
Silver Spring, MD

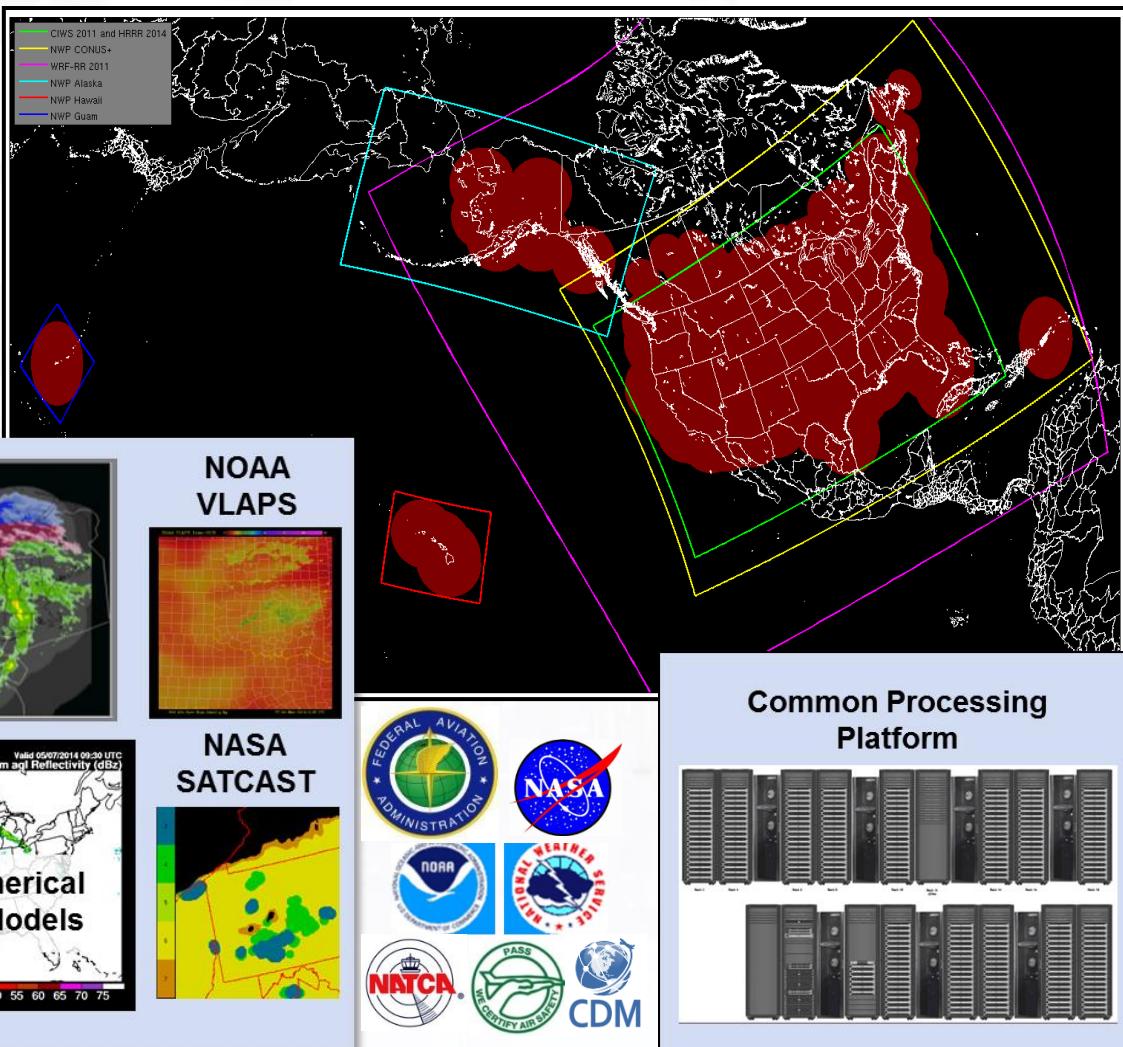
Outline

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- NextGen Weather Processor products
- WXXM product mapping patterns
- Time representations
- Representing feature display colors
- Common feature properties
- Data model example
- Changes and additions to NAWX schema
- Summary

NextGen Weather Processor

- CONUS+, Alaska, Hawaii, Guam domains
- Addresses longstanding NAS weather requirements
- Consolidates and replaces legacy weather processors
- Will include Aviation Weather Display (AWD)

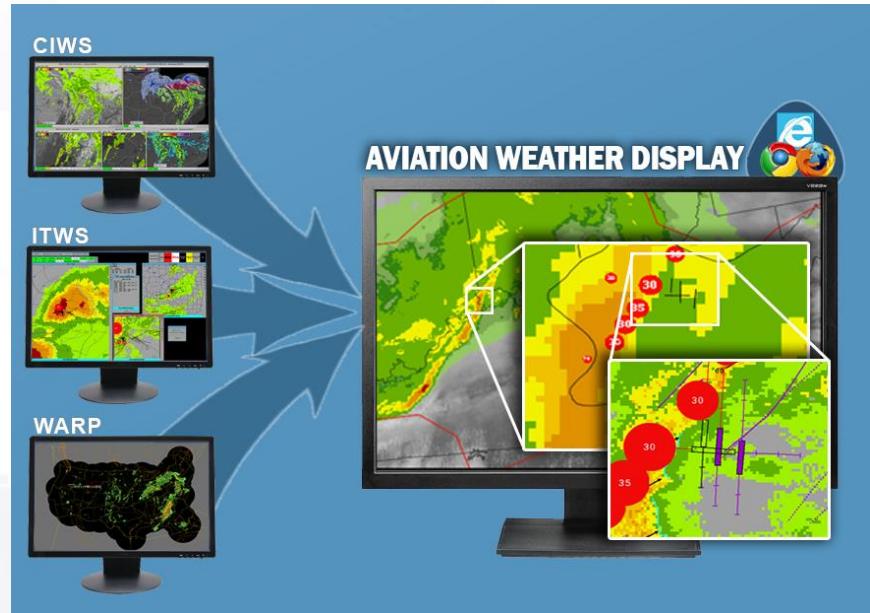


Aviation Weather Display

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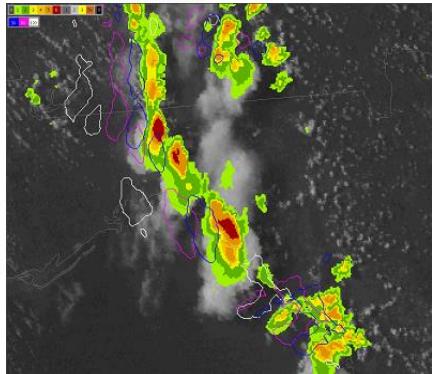
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- Procure as part of NWP
- Consolidates legacy displays
 - WARP Briefing Terminal
 - CIWS Situation Display
 - ITWS Situation Display
 - Safety critical wind shear alerts
 - Low latency update rates
- Geographic Information System
 - Tightly coupled to CSS-Wx
 - Ingest pre-rendered image layers
- Design permits terminal products to be viewed by all users
- Web-browser capability in addition to dedicated displays
- Displays weather products tailored to ATC user needs
 - High “glance value” during real-time operations – always available
 - Screen not visually crowded with traffic & other decision support content

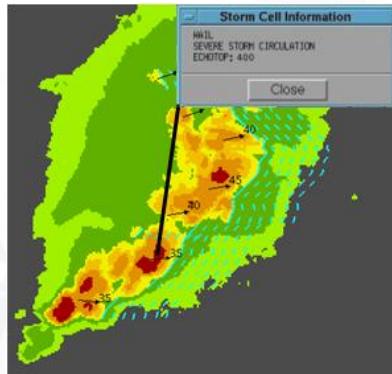


Non-Gridded Data Products

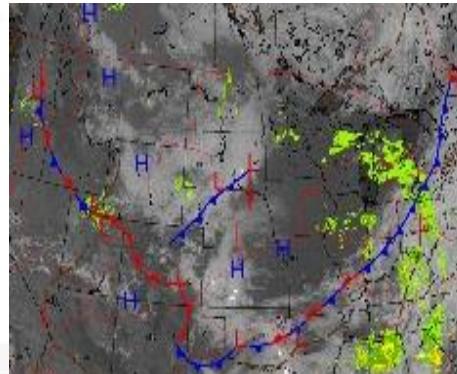
- Non-gridded products express singular or sparsely distributed geospatial sets of observations or forecasts
 - Contours, point products, text products



Precipitation Contours



Storm Motion Vectors,
Extrapolated Positions,
Hazard Text



Fronts



Microbursts

- XML format and extensions used to represent non-gridded data
 - Geography Markup Language (GML), Observations and Measurements (OM), Weather Exchange Model (WXXM), North American Weather (NAWX)
 - Changes to NAWX needed to support NWP products (no changes to WXXM)
- Geo-reference coordinates (latitude, longitude) used to represent locations.

NWP Non-Gridded Data Products

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Type	Product
Domain	VIL Forecast Accuracy with Standard, Weak Thresholding
	Echo Tops Forecast Accuracy
	Aggregated Lightning Flashes
	Storm Information Echo Tops
	Storm Information Hazard Texts
	Storm Information Leading Edges
	Storm Information Motion Vectors
	Storm Information Precipitation Cells
	Fronts and Fronts Forecast
	Trends
	Forecast Confidence
	VIL Mosaic and Forecast Contours with Standard , Weak Thresholding
	Echo Tops Mosaic and Forecast Contours
	Convective WAF Mosaic and Forecast Polygons
	Wind Profiles
	Aggregated Tornado Detections
	Jet Stream
	Airport Status Summary
	Domain System Status
	System Console Message

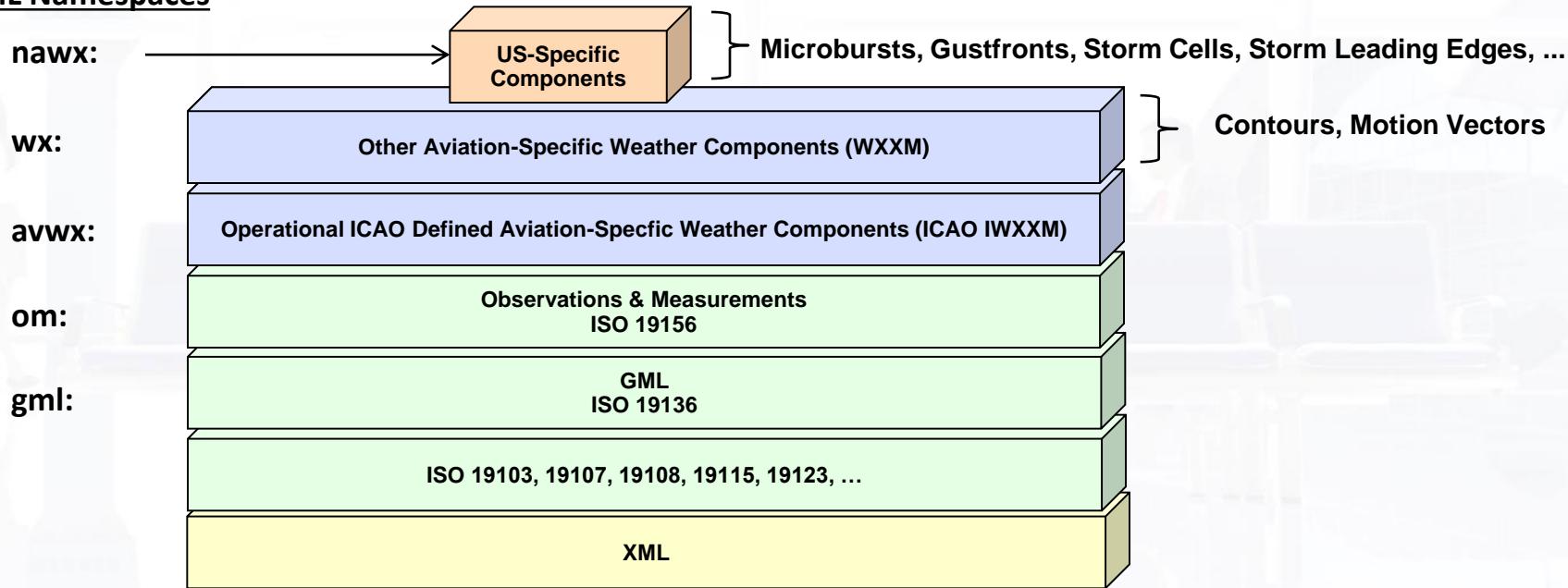
Type	Product
Terminal	Microburst TRACON Map
	Gust Front TRACON Map
	Gust Front Estimated Time of Impact
	Tornado Alert
	Configured Alert
	ATIS Panel Message
	Terminal Weather Graphics
	Terminal Weather Text
	Airport Lightning Warning
	AP Status
	Storm Information Motion Vectors (ASR)
	Storm Information Leading Edges (ASR)
	Storm Information Hazard Texts (ASR)
	Runway Configuration
	Terminal System Status
CSS-WX Hosted	Icing Layer Current and Forecast Contours
	Composite Icing with Current and Forecast Contours
	Turbulence Layer Current and Forecast Contours
	Composite Turbulence Current and Forecast Contours

WXXM Extensions for Non-Gridded Weather Products

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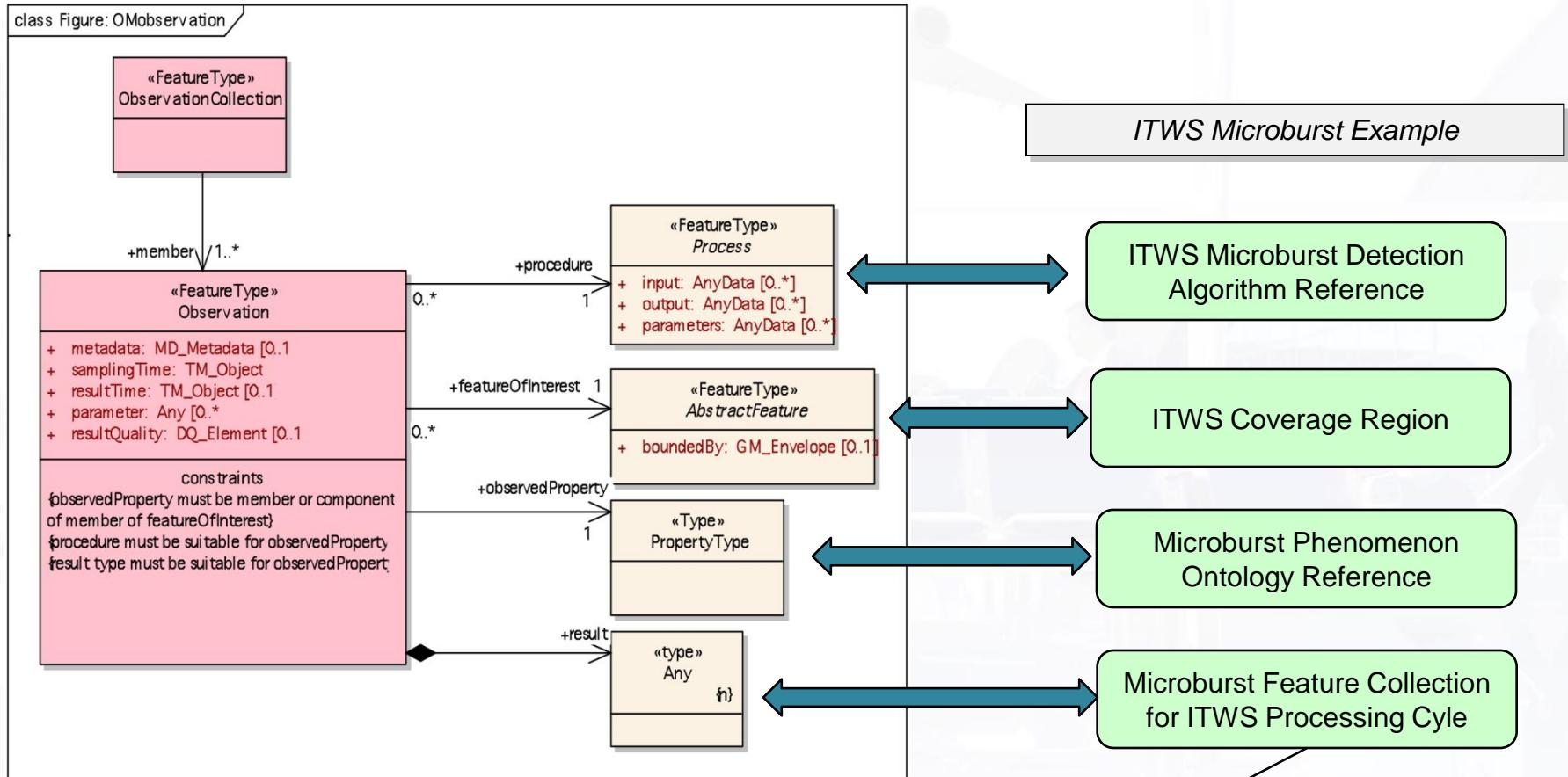
- Some products are quite general (e.g., Contours, Motion Vectors)
- Others, though potentially general, are more system-specific (e.g., Microbursts, Gustfronts)

XML Namespaces



- US (FAA) extensions defined in their own schema, using their own namespace prefix
 - ('nawx:', for 'North American Weather')
- Easily used in conjunction with other WXXM components

WXXM Product Mapping Pattern: UML View



Multiple microbursts for single processing cycle contained within single observation instance (avoid duplicate procedure, featureOfInterest, observedProperty information for each separate microburst)

WXXM Product Mapping Pattern: XML View

```
<wx:FeatureCollection> ← Top level feature collection containing Observation and/or Forecast features
<wx:featureMember>
  <wx:Observation gml:id="id2"> ← Observation type is WXXM extension that follows O&M model with additional time properties (validTime)
    <om:samplingTime/> ← Time period over which observation was made (e.g., min and max time of all radar scans)
    <om:resultTime/>
    <om:procedure xlink:href="urn:..." /> ← Process used to obtain the result (e.g., instrument, sensor, algorithm)
    <om:observedProperty/> ← Phenomenon associated with observation result (e.g., "Wind shear" ontology reference)

    <om:featureOfInterest>
      <wx:AreaOfInterest gml:id="id4"/> ← Describes the observation target
      (e.g., radar sampling area, algorithm detection domain, airport, ITWS site, etc.)

    <om:result>
      <wx:FeatureCollection>
        <gml:metaDataProperty>
          <nawx:FeatureColorsMetaData/> ← Color specifications for product display
        <wx:featureMember>
          <nawx:GustFront gml:id="id5">
            <gml:name/>
            <wx:obsOrFcstTime/>
            <wx:validTime/>
            ...
          <wx:featureMember>
            <nawx:GustFront gml:id="id6"/> ← Result contains FeatureCollection of features resulting from the procedure.
        
```



```
<wx:featureMember>
  <wx:Forecast gml:id="id6"> ← Forecast type is WXXM extension that follows O&M model with additional forecast-related time properties
    <om:samplingTime/> ← Forecast-related time information.
    <om:resultTime/>
    <om:procedure xlink:href="urn:..." />
    <om:observedProperty/>

    <wx:featureOfInterest xlink:href="#id4"/> ← Forecast may have same FOI as Observation, so we can use a link reference to the
    Observation's featureOfInterest object (ok as long as fcast is bundled with obs)

    <wx:forecastAnalysisTime/> ← Forecast result feature collection
    <wx:featureMember>
      <wx:GustFront>
    
```



```
<wx:validTime/> ← More forecast-related time information.
```

Time Representations Used for NWP Products

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wx:Observation Features

om:samplingTime	Time period over which observation was made
om:resultTime	Time when observation procedure was applied. Can be used to store product generation time or issue time.
om:validTime	Time period over which observation result is valid (can incorporate “expiration time”)

wx:Forecast Features

om:samplingTime	Time period of data used to generate forecast
om:resultTime	Time when forecast procedure was applied (may be same as observation result time)
wx:forecastAnalysisTime	aka “forecast reference time”
om:validTime	Time period over which forecast result is valid (can incorporate “expiration time”)

Result Features (e.g., MicroburstShape)

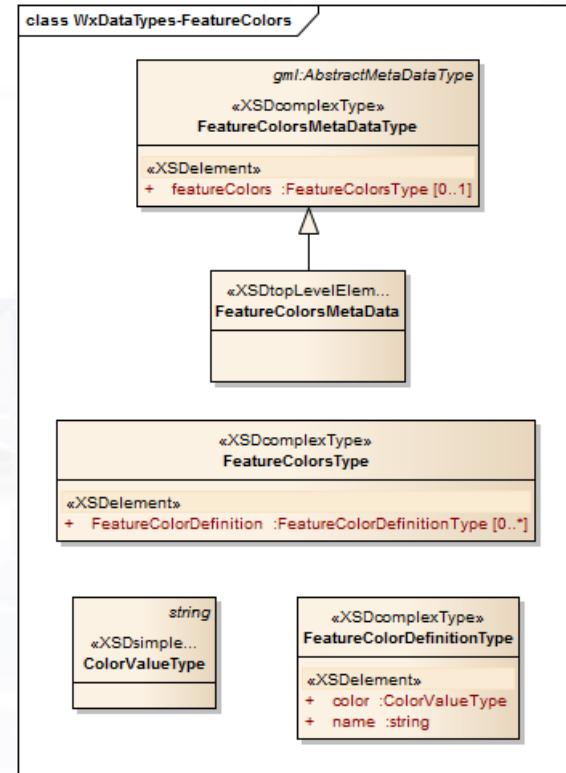
wx:obsOrFcstTime	Time instant or period associated with observed or forecast feature result.
wx:validTime	Time period over which feature is valid (can incorporate “expiration time”)

Feature Colors Metadata

- Standard graphical display colors are an important component of NWP product data
- Product display colors are represented using *nawx:FeatureColorsMetaDataTable* object within *gml:metaDataProperty* at beginning of *FeatureCollection* result

Example XML Color Definitions for Fronts Product

```
<com:result>
  <wx:FeatureCollection gml:id="id5">
    <gml:metaDataProperty about="#id5">
      <nawx:FeatureColorsMetaDataTable gml:id="id5a">
        <nawx:featureColors>
          <nawx:FeatureColorDefinition>
            <nawx:name>Fronts_Cold_Color</nawx:name>
            <nawx:color>#0000D5</nawx:color>
          </nawx:FeatureColorDefinition>
          <nawx:FeatureColorDefinition>
            <nawx:name>Fronts_Warm_Color</nawx:name>
            <nawx:color>#D50000</nawx:color>
          </nawx:FeatureColorDefinition>
        </nawx:featureColors>
      </nawx:FeatureColorsMetaDataTable>
    </gml:metaDataProperty>
  </wx:FeatureCollection>
</com:result>
```



- Note: metaDataProperty “about” attribute contains the gml:id number of the feature collection that the color definitions apply

Common Feature Properties Used for NWP products

- All product features in the *result* feature collection start with common feature properties, followed by product-specific properties
- Common feature properties:
 - <gml:name> By NWP convention, set to same name specified for *observedProperty* of containing Observation or Forecast

```
<gml:name>
  http://www.faa.gov/ontology/wx/1.0/nwpWeatherProducts.owl#StormLeadingEdges
</gml:name>
```

- <wx:ObsOrFcstTime> The observation or forecast reference time

```
<wx:obsOrFcstTime>
  <gml:TimeInstant gml:id="id8">
    <gml:timePosition>2008-07-09T04:00:00Z</gml:timePosition>
  </gml:TimeInstant>
</wx:obsOrFcstTime>
```

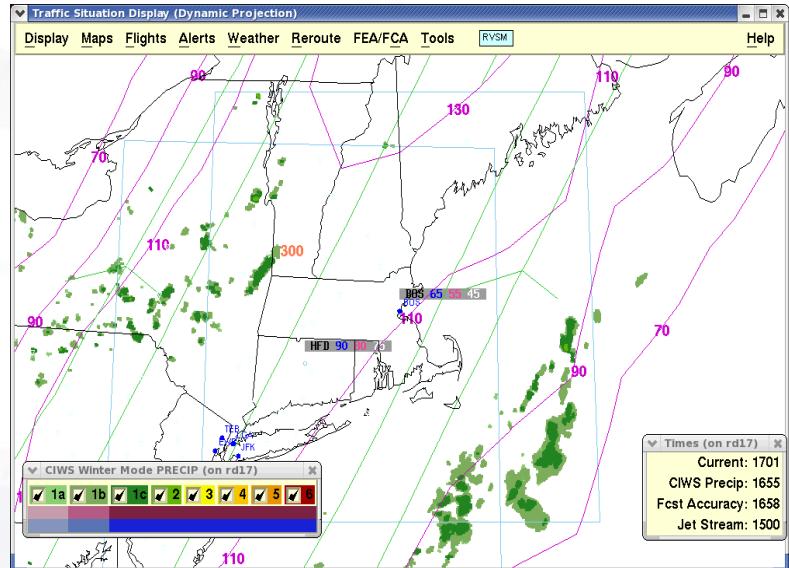
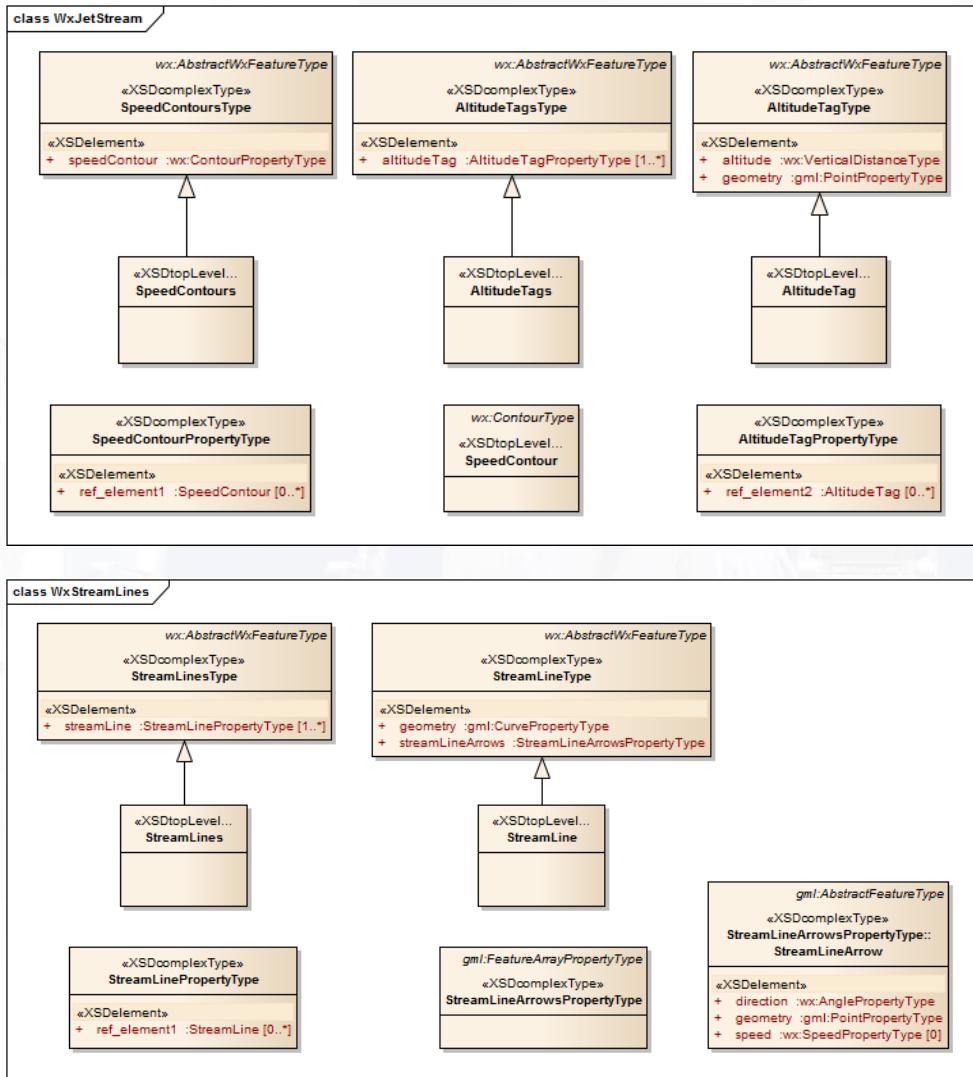
- <wx:validTime> Encodes time period over which observation or forecast is valid

```
<wx:validTime>
  <gml:TimePeriod gml:id="id23">
    <gml:beginPosition>2008-07-09T04:10:00Z</gml:beginPosition>
    <gml:endPosition>2008-07-09T04:17:30Z</gml:endPosition>
  </gml:TimePeriod>
</wxValidTime>
```

Jet Stream Data Model

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Source: TFMS Reference Manual
TSD Version 8.9, July 26, 2011

Jet Stream Product Features:

- Streamlines
- SpeedContours
- AltitudeTag

Jet Stream XML Example (Notional Result Fragment)

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```
<com:result>
<wx:FeatureCollection gml:id="id4">
  <!-- First feature member is a StreamLines collection -->
  <wx:featureMember>
    <nawx:StreamLines gml:id="id6">
      ...
      <nawx:streamLine>
        <nawx:StreamLine gml:id="id9">
          <nawx:geometry>
            <gml:Curve srsName="urn:...EPSG:4326" gml:id="id10">
              <gml:segments>
                <gml:LineStringSegment>
                  <gml:posList srsDimension="2" count="6">
                    38.0000 -94.5000 ...
                  </gml:posList>
                </gml:LineStringSegment>
              </gml:segments>
            </gml:Curve>
          </nawx:geometry>
        <nawx:streamLineArrows>
          <nawx:StreamLineArrow gml:id="id11">
            <nawx:geometry>
              <gml:Point srsName="urn:...EPSG:4326" gml:id="id12">
                <gml:pos>38.0000 -94.4000</gml:pos>
              </gml:Point>
            </nawx:geometry>
          <nawx:direction>
            <wx:Angle>90.0</wx:Angle>
          </nawx:direction>
        </nawx:StreamLineArrow>
        <nawx:StreamLineArrow gml:id="id13">...
      </nawx:StreamLineArrows>
    </nawx:StreamLine>
  </nawx:streamLine>
  <!-- Additional nawx:streamLine elements may follow -->
</nawx:StreamLines>
</wx:featureMember>
```

```
<!-- Second feature member is a SpeedContours collection -->
<wx:featureMember>
  <nawx:SpeedContours gml:id="id16">
    ...
    <nawx:speedContour>
      <wx:Contour gml:id="id19">
        <wx:contourValue uom="kt">70</wx:contourValue>
        <wx:geometry>
          <gml:Curve srsName="urn:...EPSG:4326" gml:id="id20">
            <gml:segments>
              <gml:LineStringSegment>
                <gml:posList srsDimension="2" count="6">
                  38.0000 -94.5000 ...
                </gml:posList>
              </gml:LineStringSegment>
            </gml:segments>
          </gml:Curve>
        </wx:geometry>
      </wx:Contour>
    </nawx:speedContour>
    <!-- Additional nawx:speedContour elements may follow here -->
  </nawx:SpeedContours>
</wx:featureMember>

<!-- Third feature member is an AltitudeTags collection -->
<wx:featureMember>
  <nawx:AltitudeTags gml:id="id21">
    ...
    <nawx:altitudeTag>
      <nawx:AltitudeTag gml:id="id24">
        <nawx:altitude uom="ft">30000</nawx:altitude>
        <nawx:geometry>
          <gml:Point srsName="urn:...EPSG:4326" gml:id="id25">
            <gml:pos>38.0000 -94.3000</gml:pos>
          </gml:Point>
        </nawx:geometry>
      </nawx:AltitudeTag>
    </nawx:altitudeTag>
    <!-- Additional nawx:altitudeTags may follow here -->
  </nawx:AltitudeTags>
```

XML Schema Changes and Additions for NAWX Version 1.6

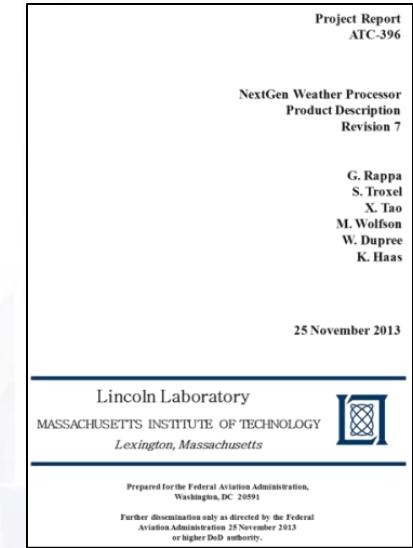
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New Schema Files	Notes
wxConvectiveWafPolygon.xsd	Convective Weather Avoidance Polygons
wxJetStream.xsd	Jet Stream product (speed contours, altitude tags)
wxRunwayConfig.xsd	Supports ITWS Runway Config product
wxStatus.xsd	Airport Status Summary, System Status, System Console Message
wxStreamLines.xsd	Generic data types for stream lines. Used for Jet Stream product.
wxWindProfiles.xsd	Supports ITWS Terminal Wind Profiles

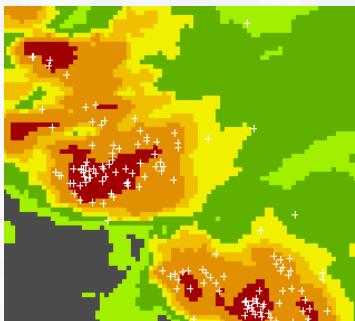
Modified Schema Files	Notes
wxAlert.xsd	Additional gust front, tornado, lightning alert properties
wxConfiguredAlerts	Added runwayValidTime property. Added data types for runway alert and ribbon display configuration information
wxDataTypes	Added data types for specifying display colors metadata
wxGustFront.xsd	Added displayedWindSpeed property
wxMicroburstShape.xsd	Added displayedDeltaV property
wxPhenomHazards.xsd	Added RunwayWindShear and RunwayWx features
wxStormCell.xsd	Added textSize and hazardText properties
wxTerminalWx.xsd	Added msgType, textSize properties
wxTornado.xsd	Added nillable properties to MovementDescriptionType

Summary

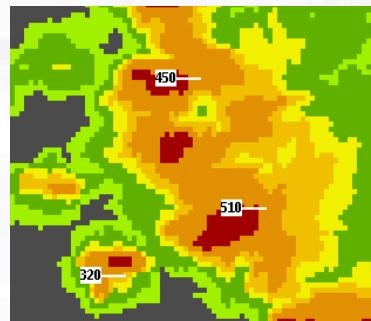
- XML Schema for NAWX extensions to WXXM written to support NextGen Weather Processor (NWP) products
 - Additions and modifications to prior NAWX schemas for ITWS, CIWS products
 - NWP product formats documented in MIT LL report ATC-396
 - NAWX version 1.6 release pending
- Real-time adapter software presently being written to translate non-gridded product data to WXXM/NAWX XML formats
- NWP Aviation Weather Display (AWD) will utilize new XML formats



AWD Product Display Examples



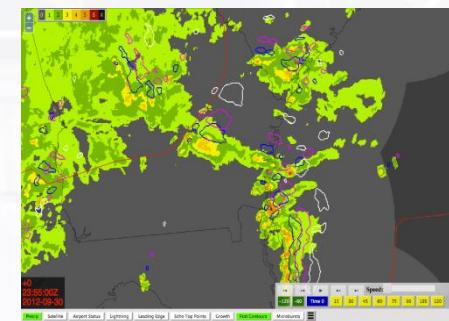
Lightning



Echo Tops Tags



Microbursts



VIL Forecast Contours

- Further refinements to data models may be needed as implementation and use proceeds

Questions

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Contact Information

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